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WATER QUALITY MANAGEMENT PLANNING.
ENVIRONMENTAL ASSESSMENTS FOR
EFFECTIVE WATER QUALITY MANAGEMENT
PLANNING

Norbert Dee, et al

Battelle Columbus Laboratories
Columbus, Ohio

April 1972

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The material provided in this report is to give guidance where needed to State, regional and local planners responsible for preparing environmental assessments in basin, metropolitan, and regional water quality management plans required by 18CFR601.32-33 and consistent with the Water Quality Management Planning Guidelines.

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ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D. C. 20460

APRIL 1972

Water Quality Management Planning

**ENVIRONMENTAL ASSESSMENTS
FOR EFFECTIVE WATER QUALITY
MANAGEMENT PLANNING**

This report was prepared by:



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INTRODUCTION

This report has been prepared to give guidance where needed to State, regional and local planners responsible for preparing environmental assessments for basin, metropolitan, and regional water quality management plans consistent with the Water Quality Management Planning Guidelines and as required by 18CFR601.32-33. Specifically, the objectives are to equip the reader to identify and describe the broad scope of environmental impacts that can result from water quality management plans. The material presented is based on techniques developed by Battelle-Columbus for evaluating the environmental effects of water resources planning.

The National Environmental Policy Act of 1969 (see Appendix A) requires that all Federal actions significantly affecting the quality of the human environment be accompanied by an environmental impact statement describing the ways in which the proposed action would affect the environment. The objective of this Act is to build into Federal Agency decision-making processes an appropriate and careful consideration of all environmental aspects of proposed actions.

In accordance with the National Environmental Policy Act (NEPA), the Environmental Protection Agency (EPA) is responsible for preparing environmental impact statements on water quality management plans and resultant wastewater treatment projects that significantly affect the environment. To carry out this task, EPA requires that environmental assessments be prepared for all plans and projects prior to submittal. These assessments are to provide data and information needed for EPA to develop the required environmental impact statements.

This report describes one method of conceptualizing the environment and is designed to acquaint planners with the scope of environmental factors that must be considered in evaluating the impacts of a proposed plan. That is, the report outlines those environmental elements that should be considered throughout the planning process as required by the Water Quality Management Planning Guidelines. If properly prepared, the water quality management plan is, in fact, the environmental assessment. The environmental conceptualization suggested in this report should not be construed as a required method for analyzing the environmental effects of a water quality management plan, but rather should be considered as a helpful guide.

It should be emphasized that environmental considerations must be integrated throughout the planning process. It is essential from the first stages of water quality management planning that the full spectrum of both adverse and beneficial impacts likely to result from the plans and resultant wastewater treatment projects be understood.

At the heart of environmental assessment is the need to take a broad view of the environment, encompassing physical/chemical, ecological, aesthetic, and social factors. Another key point is the necessity to consider and evaluate complete packages of feasible alternatives for meeting stated water quality goals. Evaluation of alternatives is essential in the planning process to identify the most environmentally acceptable plan. It is not the intent of NEPA that alternatives be screened solely on the basis of environmental impact, but simply to insure that environmental amenities are given due consideration along with technical considerations, costs, and public desires.

CHAPTER 1. ELEMENTS OF ENVIRONMENTAL ASSESSMENT

The overall goal of environmental assessment, as defined by the National Environmental Policy Act, is to insure that Federal actions

"... encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation. . ."

This chapter discusses the basic intent of the assessment process, the scope of the process, and how the results of an assessment can be useful to State, regional, and local planners.

Intent

The environmental assessment is intended to insure that water-quality-management planning and related activities contribute to the net well-being of man while minimizing or eliminating adverse impacts.

Until quite recently, quality of life was interpreted as a function of standard of living as measured by various economic indicators. It is now evident that quality of life cannot be assured through increased economic growth alone. To enhance the net well-being of man, environmental and related social factors must be analyzed before economic development activities proceed.

As stated previously, NEPA requires that environmental impact statements be prepared on major Federal actions that will have a significant effect on the environment. It is hoped that this additional dimension of environmental planning will lead to more prudent use of resources and, consequently, to a higher quality of life. Each impact statement must address the five areas of concern outlined below; indicated details that must be covered have been excerpted from EPA's "Procedures for Preparation of Environmental Impact Statements" published in the *Federal Register* (40CFR Part 6). Such impact statements will frequently be prepared on water quality management plans accepted by EPA. Environmental assessments prepared as part of these plans should address the same concerns required in an impact statement and must identify

(1) Direct Environmental Impacts of the Proposed Action

- All primary and secondary effects, both beneficial and adverse, should be described.
- The scope of the description should include both short- and long-term impacts.
- The analysis should include specifics of the area; the resources involved; physical changes; alterations to ecological systems; and changes induced by the proposed action and population distribution, population concentration, and the human use of land (including commercial and residential developments), and other aspects of the resource base such as water and public services.
- The time frames in which these impacts are anticipated should be included.
- Mention should also be made of remedial, protective, and corrective measures which will be taken as part of the proposed action should it be implemented.

(2) Adverse Impacts that Could Not be Avoided Should the Proposal be Implemented

- A description should be provided of the kinds and magnitude of adverse impacts which cannot be reduced in severity or which can be reduced to an acceptable level but not eliminated.
- For those impacts which cannot be reduced, their implications and the reasons why the action is being proposed notwithstanding their effect should be described in detail.
- Where abatement measures can reduce adverse impacts to acceptable levels, the basis for considering these levels adequate and the effectiveness and costs of the abatement measures should be specified.
- In particular, the analysis should detail the aesthetically or culturally valuable surroundings, human health, standards of living, and other environmental goals set forth in Section 101(b) of the National Environmental Policy Act.

(3) Alternatives to the Proposed Action

- Alternatives to any proposed action which involves significant trade-offs among uses of available environmental resources should be developed, described, and objectively weighed.
- Analyses should be structured in a manner which allows comparisons of environmental cost differences among equally effective alternatives, and differences in effectiveness among equally costly alternatives.
- Where practicable, impacts should be quantified or else described qualitatively in a way which will facilitate an objective judgment of their value.
- The alternative of taking no action should also be evaluated.

(4) Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

- Cumulative and long-term effects of the proposed action which either significantly reduce or enhance the state of the environment for future generations should be described.
- Particularly, the desirability of actions should be weighed to guard against shortsighted foreclosure of future options or needs.
- Special attention should be given to effects which narrow the range of beneficial uses of the environment or pose long-term risks to health or safety.
- Who is paying "the environmental costs" versus who is gaining the "benefits" over time should be identified.

- The reasons the proposed action is believed to be justified now, rather than reserving the long-term option for other alternatives, including no use, should be explained.

(5) Irreversible and Irretrievable Commitments of Resources Which Would be Involved in the Proposed Action Should it be Implemented

- The extent to which the proposed action curtails the diversity and range of beneficial uses of the environment should be described.
- Uses of renewable and nonrenewable resources during the initial and continued phases of the action shall be outlined. In this regard, construction and facility uses may be irreversible because a large commitment of resources makes removal or nonuse thereafter unlikely; such primary impacts and particularly, secondary impacts (e.g., opening areas to further development) generally commit future generations to similar uses.
- Irreversible damage which may result from environmental accidents associated with the action should be considered.
- Any irretrievable and significant commitments of resources should be evaluated to assure that such current consumption is justified.

In addition, the environmental assessment should include a discussion of any measures that have been taken to permit public involvement in the formulation or selection of the proposed plan, in the identification of any environmentally-based controversies resulting from the plan, and in their resolution. It should be noted that the above-mentioned EPA "Procedures for Preparation of Environmental Impact Statements" require that public hearings be held on draft impact statements where the originating official determines that the action will have a significant impact on the environment and that a public hearing would facilitate the resolution of conflict or significant public controversy. Public hearings are also expected to be a routine part of the planning process.

The advantages of taking the above factors into consideration during the planning process is that plans can be formulated from the very beginning to minimize adverse environmental effects and maximize beneficial ones. In addition, plans can be changed most conveniently and economically during the initial planning stages.

In the past, public planning has traditionally operated in an accommodation mode, where environmental and related social structures were provided to accommodate economic forces. That is, planning was based around the desires of the population irrespective of adverse ecological and environmental consequences. The spirit of NEPA, however, suggests that environmental planning can be used to lead the way to a better quality of life. The premise is that by taking cognizance of environmental factors in the conceptualization of plan and project alternatives, one can usually find a way to achieve most objectives while eliminating major adverse impacts or perhaps even saving money.

In summary, environmental assessments are intended to motivate planners to focus their efforts on improving quality of life. This can be achieved by identifying and considering

- Direct environmental impacts of the proposed action
- Adverse impacts that could not be avoided should the proposed action be implemented
- Alternatives to the proposed action
- Relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity
- Irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Scope

The following discussion outlines the broad spectrum of factors related to overall quality of life likely to be influenced adversely or beneficially by water quality management plans. These are the factors which, therefore, must be addressed in environmental assessments. It is especially important to consider indirect impacts outside the water sector.

Consider a hypothetical river basin which has farming as the principal activity, but includes several small towns and a large metropolitan area. Also in the basin are sizeable land areas used for recreation, open space, and stone and gravel operations. The metropolitan area has grown 20 percent in the last 10 years and this trend is expected to continue in the near future. Several large industries are located in the city, and there are immediate plans for developing a new industrial park. Some of the existing industries are served by the present municipal waste treatment system, while others discharge their untreated effluents into the river. Stormwater runoff is treated in the metropolitan area, but not in any of the small towns.

For illustrative purposes, assume that a basin plan for the entire river basin including the metropolitan area is to be developed. Under the discussion of alternatives, the plan would include

(1) Treatment of wastes from

- agricultural activities
- mining operations
- municipalities
- industries
- stormwater runoff

(2) Sludge disposal from all wastes

(3) Transfer of wastes (treated and untreated) and sludges via water, pipeline, and truck

(4) Industrial reuse of treated sewage effluent.

Some of the environmental considerations of this plan might concern

(1) Growth expected along new interceptor and sewer lines

- Is the growth compatible with existing land uses?
- Is the growth socially acceptable in that area?
- Does the growth overburden services in that area? (water supply, waste treatment, school, police, etc.)

(2) Waste treatment

- Does it improve the environmental quality of the basin?
- Is the dissolved oxygen in the river improved significantly?
- Is there an improvement in the aquatic ecosystems in the basin?
- Does the reused water create potential hygienic problems?

(3) Site location for treatment plants

- Is the site compatible with adjacent land uses?
- Does the plant location disrupt the aesthetic composition of the area?
- Are any individuals relocated?
- Is the terrestrial ecology disturbed?

(4) Sludge and solid waste disposal

- Does incineration of sludge create air pollution problems?
- Do the spoils from the mining activities affect the aesthetic composition of the area?
- Is the soil suitable for sludge disposal?

These questions and many more should be asked concerning the environmental aspects of an areawide water quality management plan. As is evident from these illustrative questions, environmental considerations are diverse, complex, and often interrelated. Therefore, if the environmental assessments are to be meaningful and to follow the guidelines of NEPA, the framework for conducting these assessments must be comprehensive, systematic, and interdisciplinary.

- **Comprehensive**, because the environment is an intricate system of living and non-living elements held together by complex processes, and because environmental concerns relating to large-scale projects range widely from physical impacts on natural resources – air, land, water – to the impacts on living organisms – plants, animals, microorganisms – to a variety of impacts on people, including aesthetic, cultural, and social concerns.

- **Systematic**, because to be effective as a decision-making planning tool, environmental impact assessments must be replicable by different analysts and must be able to withstand scrutiny by various interest groups.
- **Interdisciplinary**, because environmental concerns that are related to resources, living organisms, and people obviously require a broad range of talents and disciplines for analysis – including the physical, biological, and social sciences.

One systematic approach is to break environmental concerns into major categories, major subcategories, and ultimately into specific measurable parameters. Such an approach permits the analyst or decision maker to consider as little or as much detail as appropriate to his need at any stage of the planning. Planners should examine all parameters in detail during the early stages of planning, although ultimate decision makers and the lay public may confine their concerns to only broad impact areas or major categories.

One approach to defining the environment is to employ four major categories:

- **Physical/chemical factors** are the classical context in which the environment is usually viewed. These factors cover the impacts on the physical and chemical aspects of the air, land, and water sectors of the environment. Further, changes in the chemical and physical quality of the environment precipitate impacts in the three remaining categories: ecological, aesthetic, and social.
- **Ecological factors** cover impacts on life forms of the natural environment. Both plant and animal life are included. These factors address the question of species density and distribution, the broader question of species interaction in communities and finally, the interaction communities and habitats in an ecosystem.
- **Aesthetic factors** relate to the visual and other sensory effects of construction and land use that may result as part of a water-quality improvement plan. These include both indirect visual impacts on natural settings (air, land, and water) and direct visual impacts of man-made structures.
- **Social factors** include those that affect overall human well-being, human health, and the quality of life.

Further breakdown of these major categories into specific measurable parameters is discussed in Chapter 2.

Results

The following discussion is designed to illustrate how the results of an environmental assessment can assist planners in maximizing the net beneficial impact of their activities.

The ultimate purpose of an environmental assessment is to provide a basis for judging the overall merit of a proposed plan and its alternatives for water quality improvement. As such, the environmental assessment must identify, develop, and analyze in detail the pertinent issues and the pros and cons of alternative courses of action. Consequently, the key to meaningful environmental assessment is the identification of typical alternatives at the planning stage, as opposed to the piecemeal modification of plan components after problems become apparent.

This approach is based on the premise that any given water quality improvement objective can be achieved by a number of different paths. Further, each path will have not only different dollar costs at the planning, construction, and maintenance stages but also different environmental impacts. To select the best overall plan, decision makers need to know the net environmental impact of each alternative package or plan. The sequence of steps in the planning process ranging from the definition of problems to the analysis of environmental impact is shown in Figure 1.

At this point, reconsider the previously discussed example of the river basin and the proposed areawide plan. Options that need to be considered include alternate routes for sewers, collectors, and interceptors; alternate site locations for a treatment facility; alternate treatment processes; and alternate sludge disposal techniques. Exploring the sewer routing a bit further, one route may require construction through a wooded area with possible ecological impacts whereas another may follow well-established roads, which when torn up may cause hardship and inconvenience on adjoining residences or businesses — a form of social impact. Another route may avoid both types of problems but may require substantial pumping; in addition to being expensive, this alternative would place a burden on energy resources and upon those sectors of the environment affected by energy generation facilities through thermal pollution or various forms of air pollution. Identification of these kinds of possibilities at the early planning stages leads rapidly to identification of alternate ways of performing nearly every subfunction that must be provided for in a complete plan to meet a specific set of objectives.

The result of an environmental impact analysis should be an identification and an evaluation of impacts for each alternative considered. Both beneficial and adverse impacts must be analyzed. Environmental assessment is basically a two-step process. The first step is an *identification* of the nature of the impacts — beneficial or adverse; usually some form of checkiist is useful in insuring that important factors are not overlooked. The second step is an *evaluation* of impacts. Impacts must be evaluated with respect to two important attributes — their magnitude and importance; both are essential if trade-offs are ultimately to be made.

As has been mentioned, it is not the intent of the Environmental Policy Act that alternative water quality management plans be screened on the basis of their environmental and related social impacts alone. Economic development is another important factor. Finally, there are dollar cost considerations; traditionally this has been the major decision criterion by which projects were selected. The best alternative was one interpreted as that requiring the least investment to meet a rather narrowly defined objective.

Now, however, to be responsive to contemporary needs, broader objectives relating to quality of life need to be included. Consequently, consideration must be given to environmental and related social effects that cannot be articulated in dollar terms. Explicit consideration of nonmonetary values greatly complicates the decision-making process; however, this is not a valid excuse for not analyzing and identifying these concerns as well as possible. Ultimately, the final selection will be a trade-off of man's short- and long-term uses of the environment. Environmental assessments help to insure that the best overall decision is made.

The key elements of environmental assessment may be summarized as follows:

- Environmental assessments identify beneficial and adverse impacts, alternative actions, short-term vs. long-term trade-offs, and irreversible commitments of resources in any proposed action.

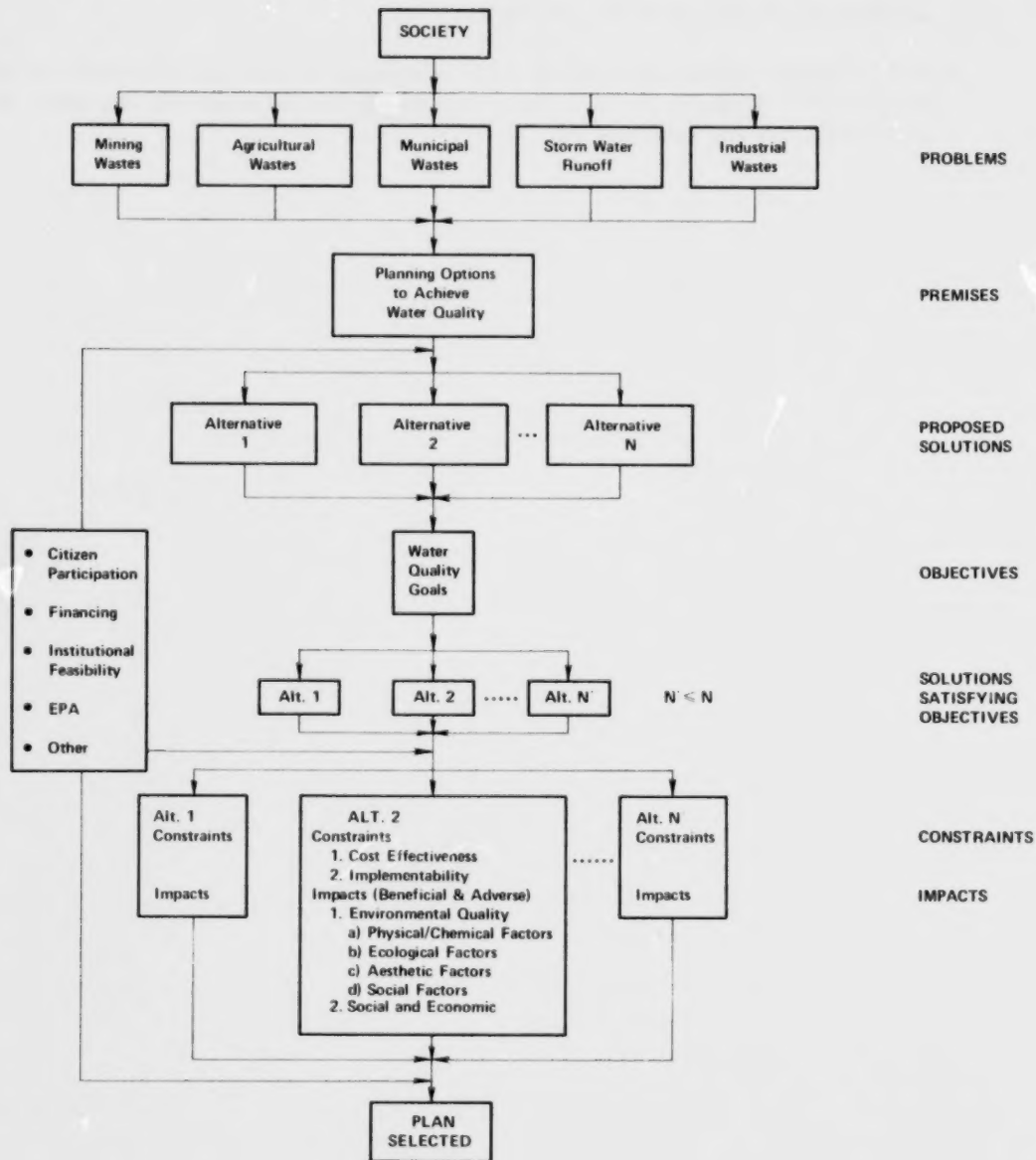


FIGURE 1. RELATIONSHIP OF ENVIRONMENTAL ASSESSMENT TO WATER-QUALITY MANAGEMENT PLANNING

- Environmental assessments should be conducted in a comprehensive, systematic, and interdisciplinary framework which emphasizes the indirect and direct impacts of water quality management plans.
- Four major categories can be used to describe environmental impacts: physical/chemical, ecological, aesthetic, and social.
- Environmental assessment, involving (1) identification and (2) evaluation of the importance and magnitude of impacts, can be used to determine the net effect of a given alternative on quality of life.

CHAPTER 2. SYSTEMATIC VIEW OF THE ENVIRONMENT

In preparing an effective water quality management plan, it is necessary to assess systematically the environmental impacts of all reasonable alternatives prior to the selection of a plan. This chapter discusses one systematic and useful framework for viewing the environment — one that breaks environmental concerns down into the four previously defined major categories — physical/chemical, ecological, aesthetic, and social — into components and ultimately into specific measurable parameters.

Before one can adequately perform an environmental assessment using the approach outlined in this report, it is necessary to understand the above four categories used to define the environment. This chapter includes a discussion of the components and parameters comprising the four environmental categories and the interactions of the components which form an environmental web.

Environmental Components

The following discussion introduces the reader to environmental components — the next level of classification below the four environmental categories in the systematic approach to environmental analysis. These components and their relationships to the four major categories are shown in Figure 2.

Each of these components indicates a subcategory of the environment that may be altered by the implementation of a water quality management plan. These components and the types of environmental concern that they bring to mind are described below.

Physical/Chemical

Water. Water as a resource is a necessary part of human, plant, and animal life cycles, a source of man's recreation and navigation, and a carrier and assimilator of waste materials. This component contains parameters measuring any change in the quality, quantity, or distribution of water.

Some of the questions that should be asked concerning water include:

- Are *fecal coliforms* reduced because of waste treatment?
- Is the *turbidity* of surface waters increased because of poor practices in the construction of sewer lines?
- Is *stream flow* reduced because of flow diversion to a regional treatment plant?
- Does agricultural runoff contain *pesticides*?
- Is *groundwater* affected by wastewater disposal practices?

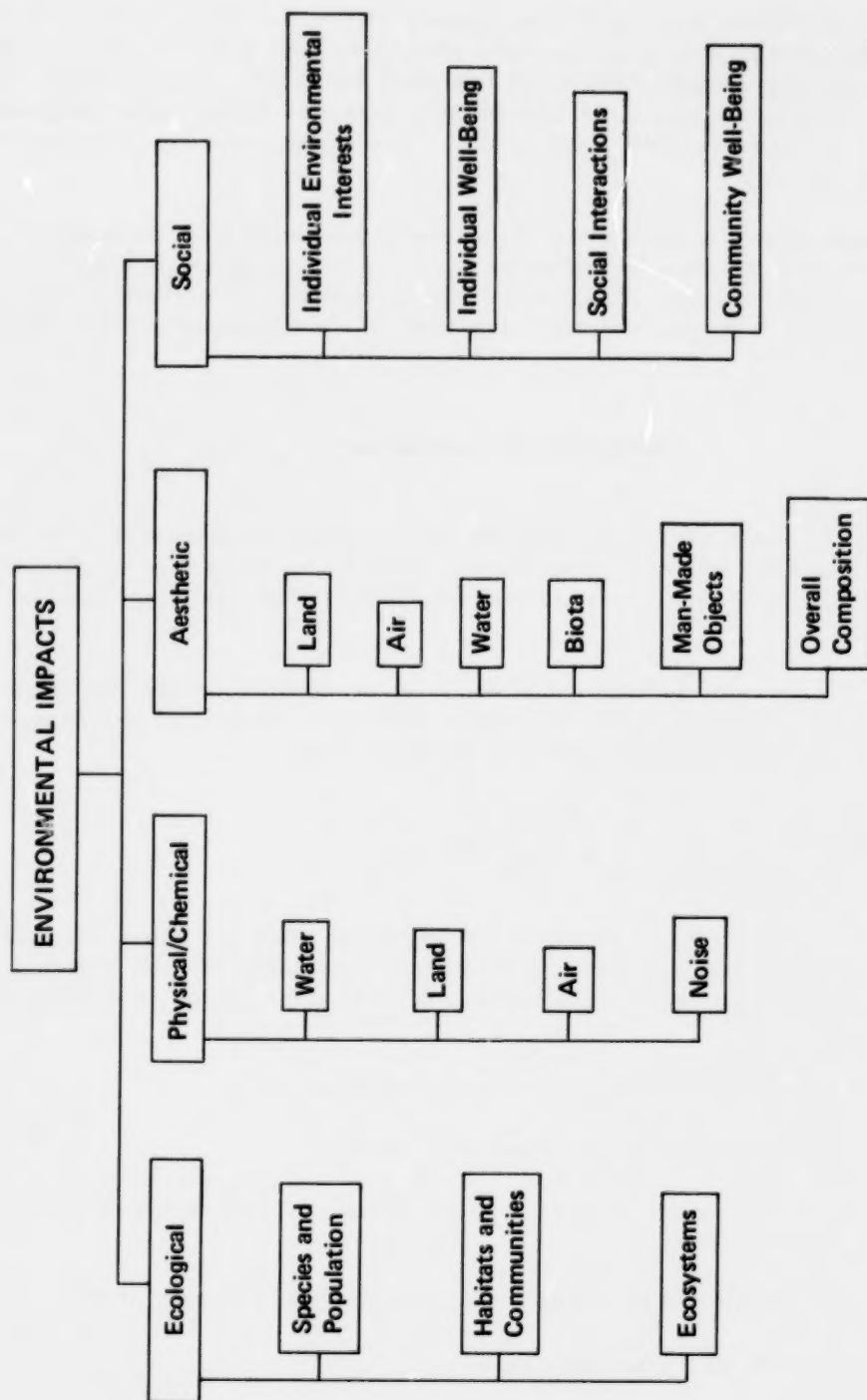


FIGURE 2. ENVIRONMENTAL CATEGORIES AND COMPONENTS
FOR ENVIRONMENTAL ASSESSMENT

Land. Land is used by man for agricultural production, residential and industrial development, resource development, and open space conservation. Each of these uses has been mismanaged on one occasion or another and has contributed to environmental problems. Effective land use management is a key to environmental quality enhancement.

Some of the questions that should be asked concerning land include:

- Do construction practices at the plant site cause *soil erosion*?
- Is the treatment plant complex compatible with adjacent *land uses*?
- Are the solid waste disposal practices for the *mine spoils* adequate?

Air. The air that supports life on this planet has become a sink for many wastes. Changes in the composition of the atmosphere may cause damages to other areas of the environment: natural vegetation, structural materials, and wildlife.

Some of the questions that should be asked concerning air include:

- Is *particulate matter* increased by the dust from the construction practices?
- Are *sulfur oxides* increased because of the additional power needs to support the population growth catalyzed by new sewer lines?
- Does incineration of waste sludge increase the *particulate matter*?

Noise. Noise is created both by man's activities and by natural phenomena. It can be desirable, such as a bubbling brook or the singing of birds, or undesirable, such as factory operation or excessive blowing of car horns. Undesirable sounds which have a physiological effect on man and nature are reflected in this component.

Some of the questions that should be asked concerning noise include:

- Does the blasting of rock during construction of a treatment plant or sewer lines change the *intensity of noise* in the area?
- Does the truck traffic into a new industrial area served by expanded sewer lines increase the *frequency of noise* in an adjacent neighborhood?

Ecological

Species and Populations. Species and populations form the basic building blocks of ecology. Traditionally, most ecological analyses have been concerned solely with these building blocks. However, data are not available for all aquatic and terrestrial species. For this reason, indicator species are used to inform man on the overall well-being of species and populations. Indicator species commonly employed include those of direct commercial or economic value to man, those that are representative of a healthy, balanced environment, and those that are harmful to man.

Some of the questions that should be asked concerning species and populations include:

- Is the *natural vegetation* at the plant site significantly affected?
- Is the degree of treatment provided for all wastes adequate to protect *fisheries*?
- Is the development of *pest species* encouraged by construction practices?
- Are *animals and birds* adversely affected by the nature and extent of vegetation removal?

Communities and Habitats. Groups of species or communities exist in environments known as habitats. The coexistence of species in habitats and communities results from a series of complex interactions and processes. Some of the major habitats are streams, lakes, impoundments, estuaries, swamps, deserts, grasslands, and woodlands, all of which exist to one degree or another in river basins throughout the United States.

Some of the questions that should be asked concerning communities and habitats include:

- Are the habitats of any *rare and endangered species* eliminated through the filling of a swamp?
- Are any biological communities critical to the *local food chain* eliminated as a result of inadequate waste treatment?
- Is the *species diversity* in an area adversely affected as a result of urbanization catalyzed by the provision of new sewer lines?

Ecosystems. The broadest scale of ecological analysis concentrates on entire natural systems such as large open spaces, reaches of rivers, forests, etc. Many processes that occur within an ecosystem are either not measurable or not completely understood by the current state of the art.

Some of the questions that should be asked concerning ecosystems include:

- Does the transition from a rural area to an urban area resulting from new sewer interceptors reduce the *land's productivity*?
- Is the *nutrient cycle* altered by the lack of nutrient removal in the waste treatment process?
- Are *energy flow* patterns disrupted by decreased water quality and/or changes in species composition.

Aesthetics

Land. Land forms in an area often create a specific scenic beauty. It is not necessary for the land forms to be mountains or canyons; small ravines in an urban or rural area can provide

highly desirable topographic relief; these land forms possess their own beauty and can contribute measurably to quality of life.

Some of the questions that should be asked concerning land include:

- Does the urban growth that follows a sewer line change the *relief* of the area?
- Is the *natural surface material* changed at the site of a treatment plant or sewer line?

Air. Aesthetic considerations related to air are based on the presence or absence of pollutants, water vapor, turbulence, and temperature. Air has maximum aesthetic appeal when it is free of pollutants, low in humidity, moderate in temperature, and low in velocity. The primary effect man has on the air is through the emission of air pollutants which may offend sight, smell, or both. In addition to the odor and sight, sounds can be considered as an air-related aesthetic parameter. Sounds can clash with or add to the peace and solitude of nature.

Some of the questions that should be asked concerning air include:

- Is *visibility* reduced due to dust caused by construction practices?
- Is there *an odor* from the incineration of waste sludge?
- Are the *sounds* from song birds eliminated by changes in their habitats?

Water. Water is extremely important in the overall aesthetic quality of a river basin. The aesthetic qualities of a water body relate to the characteristics of the water itself and to the interface between land and the water, i.e., shoreline characteristics.

Some of the questions that should be asked concerning water include:

- Is *stream flow* increased because of discharges from a regional plant?
- Does the plant remove all *floating materials*?
- Does the construction of man-made channels eliminate the *natural land and water interface*?

Biota. Plants and animals contribute to the aesthetic qualities of a river basin or metropolitan area. Although the type of vegetation considered the most desirable is subject to personal preference, most people prefer vegetation over concrete or bare surface material. With adequate vegetation as a habitat, the area will support larger populations of birds and other animals. Areas with both vegetation and animals are of high aesthetic quality.

Some of the questions that should be asked concerning the biota include:

- Do changes caused by population growth along new sewer lines change the *vegetation diversity*?

- Does the clearing for sewer routes eliminate a particular *vegetation type*?
- Are *animals* removed from the site selected for a treatment plant?

Man-Made Objects. The aesthetic attractiveness of things built by man are generally related to their beauty, uniqueness, age, and historical significance. The location and design of the structures and the landscaping of the structures can have a pronounced visual effect.

Some of the questions that should be asked concerning man-made objects include:

- Is the plant design in *consonance* with the environment?
- Are the man-made objects to be built along new sewer routes in *consonance* with the environment?

Composition. Composition reflects the combination of all elements that make a location look and "feel" like it does. Composition is a subjective evaluation in response to the total "picture".

Some of the questions that should be asked concerning aesthetic composition include:

- Is the *mood or atmosphere* of a location destroyed by a treatment plant?
- Will the construction of sewer lines result in population growth and subsequent uncontrolled *commercial growth* in new areas?

Social

Individual Environmental Interests. Individual interest aspects of the environment are those which provide something beyond the absolute necessities for human life; they affect people's emotional lives; they add to the enjoyment of life. Recent trends in education, leisure time, and per capita income indicate an increasing demand for locations where individuals can enjoy the natural environment.

Some of the questions that should be asked concerning individual environmental interests include:

- Does the improved water quality of a river improve *educational opportunities*?
- Are sludge disposal sites located in the immediate proximity of a *historical site*?
- Does deterioration of water quality in a river from lack of adequate treatment reduce its *leisure/recreational potential*?

Individual Well-Being. Individuals living in a river basin or metropolitan area rely on the public sector for adequate services. These services include a "healthy" environment, good drinking water, sewer facilities, and safety from water-borne epidemics.

Some of the questions that should be asked concerning individual well-being include:

- Does the water reuse portion of a proposed plan create *hygienic problems*?
- Is *psychological health* affected by poor water quality?
- Is *physiological health* affected by increased air pollutants from the incineration of sludges?

Social Interactions. Individuals organize themselves into specific units ranging from the family unit to the political organization to meet certain needs. These units interact directly with the environment and are often directly affected by changes in the environment. Employment opportunities, housing, and recreation are group activities that are influenced by changes in environmental quality.

Some of the questions that should be asked concerning social interactions include:

- How does the *relocation of individuals* because of treatment plant site selection affect the families involved?
- Is there economic growth and *new social opportunities* because of new facilities?
- Are *life patterns* forced to change as a result of population growth?

Community Well-Being. Individual and social interactions are part of the overall unit, the community. The well-being of a community in part depends upon the environment established in the community. Both the natural and social environment and their interface are integral parts of this environment.

Some of the questions that should be asked concerning the community well-being include:

- Does the *community prosper* as a result of the improved environment?
- Does the location of a treatment plant *disrupt the community* in any way?

Thus, a truly comprehensive environmental assessment will examine the impact of several alternatives on all of the following aspects of the environment.

Physical/Chemical

- Water
- Land
- Air
- Noise

Aesthetic

- Water
- Land
- Air
- Biota
- Man-Made Objects
- Overall Composition

Ecological

- Species and Populations
- Habitats and Communities
- Ecosystems

Social

- Individual Environmental Interests
- Individual Well-Being
- Social Interactions
- Community Well-Being

Environmental Interactions

The purpose of the following discussion is to illustrate the complex nature of interrelationships between the environmental components and to demonstrate how they are included in the analysis.

The reader must realize that the environment is not a simple list of independent blocks as shown in Figure 2, although for impact analysis it is convenient to view it in this context. In reality, the environment is a very complex web of blocks and interactions. An action by man in one area causing little direct impacts can initiate a chain of events causing a significant indirect impact in some other area.

It would be desirable to describe and measure any adverse and beneficial changes in the environment both by the blocks and by their interactions. Any given action in the environment, such as the construction of sewer lines, can have impacts reflected in more than one component of the environment; for example, the particulate matter in the form of dust from construction can have impacts on both the aesthetic and physical/chemical quality of the environment. However, many of these interactions have neither been identified nor interpreted to the point that meaningful measurements of these interactions can be taken.

In the case of developing a water quality management plan, many environmental impacts are initiated by changes in the physical/chemical components of the environment which in turn cause changes in the other components. That is, the chain or web of impacts is catalyzed by changes in the physical/chemical components.

An example will be useful to illustrate some of the many interactions created by a single element of a basin plan; it must be emphasized, however, that this example does not indicate all possible interactions, only a selected number. Assume that there are no environmental controls on the construction practices used in the building of a treatment plant. Figure 3 indicates some of the adverse environmental interactions resulting from a failure to control construction. The initial direct impacts are measured in changes in physical/chemical parameters. Changes in these parameters create changes (indicated by arrows) in the other categories: ecology, aesthetics, and social. By controlling the construction practices and, therefore, reducing the physical/chemical changes, it is possible to reduce or eliminate the other adverse impacts.

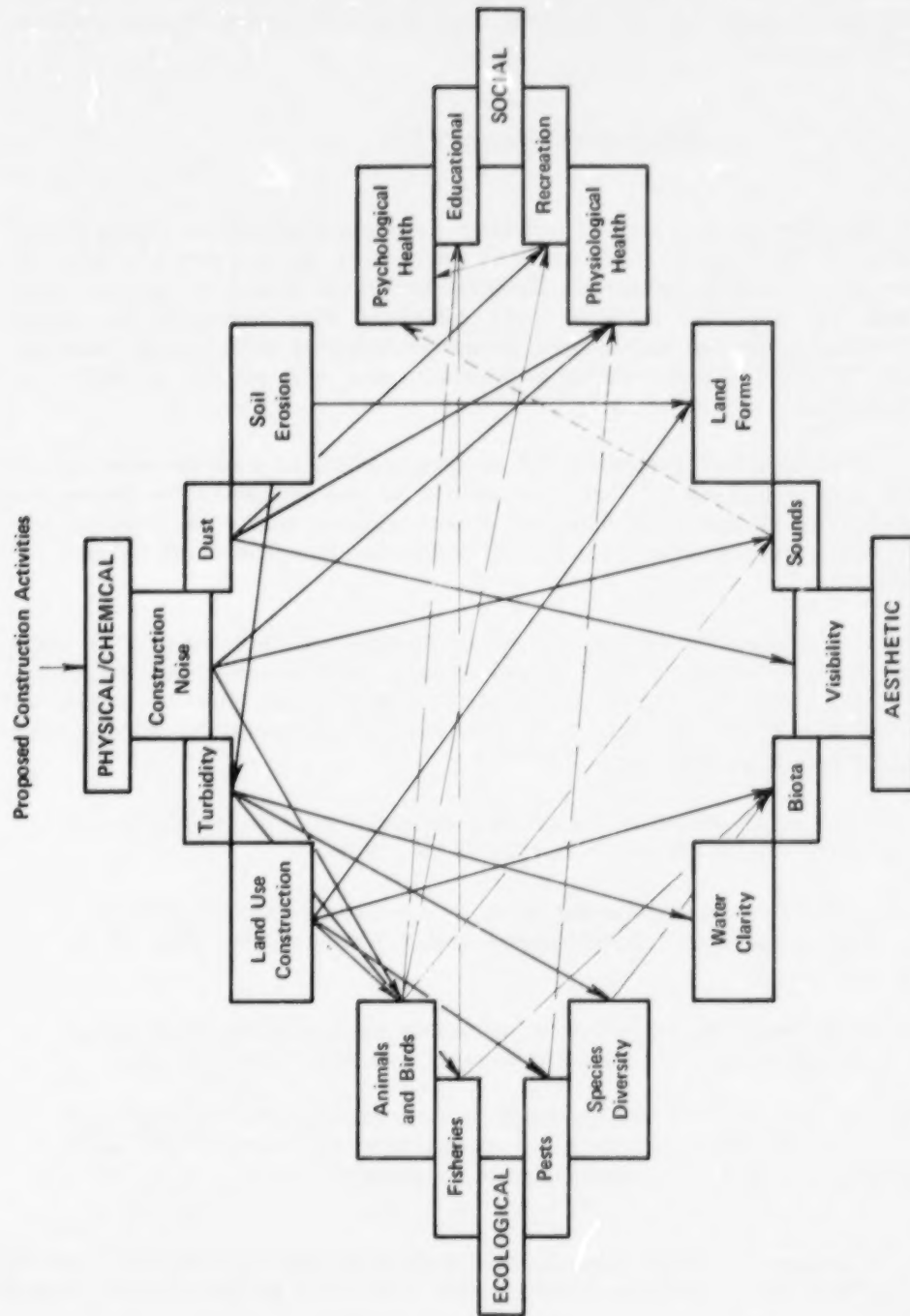


FIGURE 3. ENVIRONMENTAL IMPACTS AND INTERRELATIONSHIPS ASSOCIATED WITH PROPOSED CONSTRUCTION ACTIVITIES RESULTING FROM WATER QUALITY MANAGEMENT PLANS

In performing an environmental assessment of alternatives for managing water quality, it is desirable to recognize these interactions and to include them in the evaluation. However, due to the lack of information upon which to base analyses of linkage relationships, it is usually necessary to evaluate the parameters independently. Until more information becomes available, this is the suggested approach.

Environmental Parameter List

This section describes the next step in systematic environmental analyses. Having broken environmental concerns into 4 major categories and 17 components, the next step is to break the components down into measurable parameters. This third level relates directly to data obtainable in the field, while the other two levels are more conceptual than measurable. By making measurements or collecting data on each of these parameters reflecting environmental conditions both "with" and "without" a water quality management plan, it is possible to perform an environmental assessment.

A listing of some suggested parameters for assessing impacts of areawide water quality management plans is given in Table 1.* This is a suggested list and will need to be improved as more information is obtained and better indicators of environmental quality are developed. For reasons outlined earlier, this indicator list does not include the interactions and linkages, but only the basic blocks.

The environment can now be defined as a systematic structure consisting of three levels. The categories divide the environment into four major groups. The components and parameters, levels 2 and 3, further explain these general classifications in more precise terms. To develop the parameter data needed to provide the basis for an environmental assessment, the following steps must be followed for each alternative plan:

- Collect data or perform measurements for each parameter of environmental quality as conditions now exist in the area to be affected by a plan.
- Extrapolate current conditions into the future on a parameter-by-parameter basis so that the future condition of environmental quality "without" the plan can be estimated
- Estimate future conditions of environmental quality on a parameter-by-parameter basis to develop an estimate of future environmental conditions "with" the plan
- Determine the difference in environmental quality between the "without" and "with" condition; desirable or undesirable changes from the "without" to "with" condition indicate beneficial or adverse impacts respectively.

*Dee, Norbert, et al, "Environmental Evaluation System for Water Resource Planning", Final Report to the Bureau of Reclamation, U.S. Department of the Interior, Contract Number 14-06-D-7182, Battelle-Columbus, Columbus, Ohio, January 1972.

TABLE 1. ASSESSMENT PARAMETERS

PHYSICAL/CHEMICAL	
Water	Land
• BOD • Groundwater Flow • Dissolved Oxygen • Fecal Coliforms • Inorganic Carbon • Inorganic Nitrogen • Inorganic Phosphate • Heavy Metals • Pesticides • Petrochemicals • pH • Stream Flow • Temperature • Total Dissolved Solids • Toxic Substances • Turbidity	• Soil Erosion • Flood Plain Usage • Buffer Zones • Soil Suitability for Use • Compatibility of Land Uses • Solid Waste Disposal
Noise	Air
• Intensity • Duration • Frequency	• Carbon Monoxide • Hydrocarbons • Nitrogen Oxides • Particulate Matter • Photochemical Oxidants • Sulfur Oxides • Methane • Hydrogen and Organic Sulfides • Other
ECOLOGICAL	
Species and Populations	Habitats and Communities
• Game and Nongame Animals • Natural Vegetation • Managed Vegetation • Resident and Migratory Birds • Sport and Commercial Fisheries • Pest Species	• Species Diversity • Rare and Endangered Species • Food Chain Index
	Ecosystems
	• Productivity • Biogeochemical Cycling • Energy Flow
AESTHETIC	
Land	Biota
• Geologic Surface Material • Relief and Topography	• Animals-Wild and Domestic • Vegetation Type • Vegetation Diversity
Air	Man-Made Objects
• Odor • Visual • Sounds	• Man-Made Objects • Consonance with Environment
Water	Composition
• Flow • Clarity • Interface Land and Water • Floating Materials	• Composite Effect • Unique Composition • Mood Atmosphere
SOCIAL	
Individual Environmental Interests	Individual Well-Being
• Educational/Scientific • Cultural • Historical • Leisure/Recreation	• Physiological Health • Psychological Health • Safety • Hygienic
Social Interactions	Community Well-Being
• Political • Socialization • Religious • Family • Economic	• Community Well-Being

CHAPTER 3. ANALYTICAL METHODOLOGY

The systematic approach to environmental assessment provides a comprehensive description of what is meant by the environment. This chapter described the framework of an analytical methodology for assessing environmental impacts.

The environmental assessment must fulfill the objectives and the spirit of NEPA. For this reason, the environmental assessment of water quality management alternatives must

- (1) Consider all possible effects on the environment
- (2) Develop an overall ranking of the alternatives
- (3) Identify project elements which, if modified, could significantly enhance the environment or minimize negative impacts
- (4) Indicate areas of adverse impact that require special consideration.

To achieve these four goals, each environmental parameter must be evaluated to determine if any aspect of the specific alternative being analyzed would cause a change in environmental quality as indicated by the parameter in question. If no detectable change is predicted, there is no impact as measured by that parameter. If, on the other hand, there is a change, then it is necessary to determine its magnitude.

In addition to the magnitude and direction (adverse and beneficial) of the parameter change, it is necessary to determine the relative importance of changes in each of the parameters. Changes in all parameters do not necessarily have the same importance when determining total environmental impact. By assigning a relative importance measure to all parameters, the impacts reflected by each parameter can be put in the proper perspective.

Each water quality management alternative will affect different parameters of the environment to a different degree. To determine impacts, each parameter is measured or estimated "without" the alternative and then "with" the alternative, the difference being defined as one measure of impact. The "without" condition is defined as the expected future if the alternative were not implemented.

In measuring the "without" and "with" conditions for each alternative, spatial and temporal dimensions must be considered. The spatial dimension relate the location of the projects within the plan to the location of the impact. As an example, it is possible that the impact from a treatment plant may be many miles downstream of the plant. A framework for including the spatial dimension is to consider

- Upstream from the site
- At the site
- Transfers between sites
- Downstream from the site.

The areas to be included in this framework are not restricted to the stream alone, but include the entire area affected by the alternative. In some cases the pertinent area for evaluation would be the entire basin.

The time frame used in the evaluation of the alternative is also important. Some impacts may be short-term while others may last for many years. At least two time frames should be considered in the environmental assessment:

- During construction of the alternative
- During operation or use of the alternative.

Each alternative for managing water quality will have some beneficial impacts as well as adverse impacts on environmental quality. For example, an alternative may improve the fisheries downstream of the metropolitan area, and increase the air pollution in the metropolitan area because of incineration of sewage sludge. A means for trading off these beneficial and adverse impacts is needed to arrive at some overall assessment of net environmental impact. This would allow one to state the net impact on the environment and thus rank all alternatives. To trade-off beneficial impacts with adverse impacts and to obtain a net impact, each parameter must be assigned a weight. This weight should reflect the parameter's relative importance in the entire environmental system.

This report has provided the reader with an understanding of the broad scope of environmental impacts that can develop in conjunction with water quality management plans. The report has also described the basic elements of a systematic methodology for analyzing these impacts. Key points that State, regional, and local planners must keep in mind in preparing environmental assessments for basin, metropolitan, and regional water quality management plans are:

- Environmental assessments must be conducted in a comprehensive and systematic manner.
- A systematic view of the environment — one that breaks environmental concerns into broad categories, then into components, and ultimately into measurable parameters — offers a useful method for conducting environmental assessments.
- The process of environmental assessment is then reduced to an evaluation of each alternative with respect to each parameter under two conditions: "without" the plan and "with" the plan.
- Impacts reflected by each parameter must be evaluated with respect to their magnitude and relative importance. The difference between impacts associated with the "with" and "without" condition, aggregated in proportion to their magnitude and importance, constitutes one measure of overall net environmental impact.
- During the preparation of an environmental assessment, assistance may be obtained from State Environmental agencies as well as State Departments of Health, Natural Resources, Forestry, and Agriculture, and local universities.

A

APPENDIX

NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

Public Law 91-190
91st Congress, S. 1075
January 1, 1970

An Act

83 STAT. 852

To establish a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Environmental Policy Act of 1969".

National Environmental Policy Act of 1969.

PURPOSE

SEC. 2. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

TITLE I

DECLARATION OF NATIONAL ENVIRONMENTAL POLICY

SEC. 101. (a) The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. Policies and goals.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may—

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;

(3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

Administration.

SEC. 102. The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall—

(A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment;

(B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on—

- (i) the environmental impact of the proposed action,
- (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
- (iii) alternatives to the proposed action,
- (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
- (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Prior to making any detailed statement, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of title 5, United States Code, and shall accompany the proposal through the existing agency review processes;

(D) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

(E) recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment;

(F) make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;

Copies of statements, etc., availability.

81 Stat. 54.

(G) initiate and utilize ecological information in the planning and development of resource-oriented projects; and

(H) assist the Council on Environmental Quality established by title II of this Act.

SEC. 103. All agencies of the Federal Government shall review Review. their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act.

SEC. 104. Nothing in Section 102 or 103 shall in any way affect the specific statutory obligations of any Federal agency (1) to comply with criteria or standards of environmental quality, (2) to coordinate or consult with any other Federal or State agency, or (3) to act, or refrain from acting contingent upon the recommendations or certification of any other Federal or State agency.

SEC. 105. The policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies.

TITLE II

COUNCIL ON ENVIRONMENTAL QUALITY

SEC. 201. The President shall transmit to the Congress annually Report to Congress. beginning July 1, 1970, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, manmade, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including, but not limited to, the forest, dryland, wetland, range, urban, suburban, and rural environment; (2) current and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the Nation in the light of expected population pressures; (4) a review of the programs and activities (including regulatory activities) of the Federal Government, the State and local governments, and nongovernmental entities or individuals, with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources; and (5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation.

SEC. 202. There is created in the Executive Office of the President Council on Environmental Quality. a Council on Environmental Quality (hereinafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President to serve at his pleasure, by and with the advice and consent of the Senate. The President shall designate one of the members of the Council to serve as Chairman. Each member shall be a person who, as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds: to appraise programs and activities of the Federal Government in the light of the policy set forth in title I of this Act; to be conscious of and responsive to the scientific, economic, social, esthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

80 Stat. 416.
Duties and
functions.

SEC. 203. The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof).

SEC. 204. It shall be the duty and function of the Council—

(1) to assist and advise the President in the preparation of the Environmental Quality Report required by section 201;

(2) to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in title I of this Act, and to compile and submit to the President studies relating to such conditions and trends;

(3) to review and appraise the various programs and activities of the Federal Government in the light of the policy set forth in title I of this Act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto;

(4) to develop and recommend to the President national policies to foster and promote the improvement of environmental quality to meet the conservation, social, economic, health, and other requirements and goals of the Nation;

(5) to conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality;

(6) to document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes;

(7) to report at least once each year to the President on the state and condition of the environment; and

(8) to make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

SEC. 205. In exercising its powers, functions, and duties under this Act, the Council shall—

(1) consult with the Citizens' Advisory Committee on Environmental Quality established by Executive Order numbered 11472, dated May 29, 1969, and with such representatives of science, industry, agriculture, labor, conservation organizations, State and local governments and other groups, as it deems advisable; and

(2) utilize, to the fullest extent possible, the services, facilities, and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies.

Sec. 206. Members of the Council shall serve full time and the Chairman of the Council shall be compensated at the rate provided for Level II of the Executive Schedule Pay Rates (5 U.S.C. 5313). The other members of the Council shall be compensated at the rate provided for Level IV or the Executive Schedule Pay Rates (5 U.S.C. 5315).

Tenure and compensation.
80 Stat. 460, 461.
81 Stat. 638.
Appropriations.

Sec. 207. There are authorized to be appropriated to carry out the provisions of this Act not to exceed \$300,000 for fiscal year 1970, \$700,000 for fiscal year 1971, and \$1,000,000 for each fiscal year thereafter.

Approved January 1, 1970.

LEGISLATIVE HISTORY:

HOUSE REPORTS: No. 91-378, 91-378, pt. 2, accompanying H. R. 12549 (Comm. on Merchant Marine & Fisheries) and 91-765 (Comm. of Conference).

SENATE REPORT No. 91-296 (Comm. on Interior & Insular Affairs).
CONGRESSIONAL RECORD, Vol. 115 (1969):

July 10: Considered and passed Senate.

Sept. 23: Considered and passed House, amended, in lieu of H. R. 12549.

Oct. 8: Senate disagreed to House amendments; agreed to conference.

Dec. 20: Senate agreed to conference report.

Dec. 22: House agreed to conference report.
